Cloud analysis using LAPS in Serbia

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1. Introduction

Information about the cloud extent, type and the precipitation type and amount are very helpful and valuable for forecasters, especially in the cases of a storm event. Accurate warning about these events in the case of severe weather is important to initiate appropriate actions. LAPS provides required information, combining numerous data sources, with a high spatial and temporal resolution (Albers et al., 1996). The poster demonstrates LAPS capability to diagnose the severe weather event and also some thoughts how to use a new kind of data in the analyses.

2. Storm case and LAPS products

On July 23, 2007 a supercell storm developed over the north part of Serbia, it lasted a few hours and produced heavy rain and hail. Within activity of the hail suppression the storm was observed with Doppler radar located at Fuska Gora, about 100 km south from the storm. LAPS analyses were performed using ECMWF data as background field, synop data and radar reflectivity data from the Fruska Gora radar. The analyses ran at 06 UTC and because of that we didn't use sounding data which were available at 00 and 12 UTC. LAPS domain was centered at 45,157 ° N and 19,816 ° E which are the coordinates of the Fruska Gora radar. The grid spacing was 500 m and we had 1000 x 1000 points with 21 vertical levels.

Data preparation for LAPS:

- Background field in GRIB or GRIB2 format are directly ingested into LAPS
- Synop data are in BUFR format and had to be decoded and written again in the netCDF format as expected by LAPS
- Radar data are in vol/xml format consisting of header in ASCII format, containing relevant parameters necessary for the data decoding, and binary data portion written with 8-bit integers. These data are, also, rewritten in netCDF format.

Some results from LAPS analyses are presented on the next pictures.

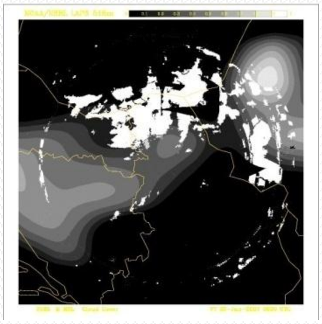


Fig 1. Cloud cover on 2100 m

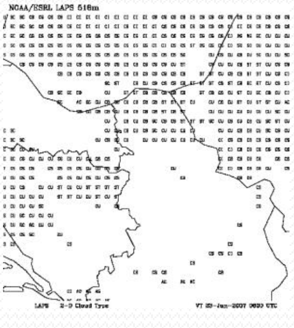


Fig 2. Cloud type

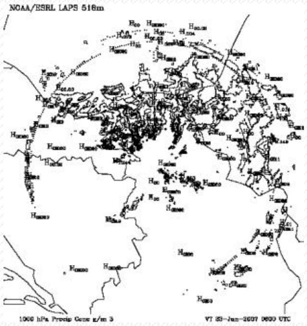


Fig. 3 Convective precipitation

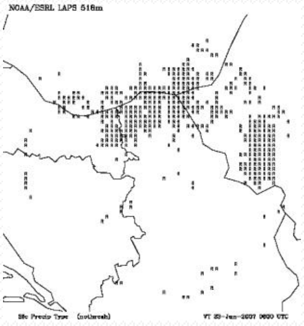
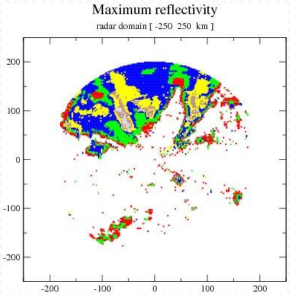


Fig. 4 Precipitation type



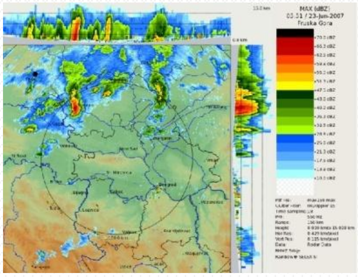


Fig 5. Maximum reflectivity (LAPS picture on the left side and RAINBOW product from Fruska Gora Gematronik radar on the right)

3. Further research and improvements

Radar data play an important role in the LAPS cloud analysis but also in the analyses of precipitation type and amount. Progress in the radar meteorology is in the direction of dual-polarization radars which has opened the new possibilities for observing inside the clouds necessary for hydrometeor discrimination and quantification. Having dual-polarization capability is essential for discriminating between meteorological and non-meteorological scatterers and for distinguishing between different hydrometeor types, such as rain, hail, graupel, and snow of different habits. Principles of fuzzy logic form the basic for most polarimetric classification algorithms. Knowledge of the hydrometeor type within radar resolution volume is required for choosing appropriate polarimetric rain rate relation to accurately quantify the amount of precipitation (Giangrande and Ryzhkov, 2008).

Relations between R, Z, K_{DP} and $N(D_e)$:

Rain rate $R \sim \int_0^{D_m} D_e^{3.67} N(D_e) dD_e$

Reflectivity factor $R \sim \int_0^{D_m} D_e^{6} N(D_e) dD_e$

Specific differential phase $R \sim \int_0^{D_m} D_e^{4.24} N(D_e) dD_e$

Z, R relations are more sensitive to $N(D_e)$ because exponents of D_e differ considerably.

K_{DP}, R relations are not as sensitive to $N(D_e)$ because exponents of D_e are similar.

Specific differential phase is almost linearly related to rain rate!

$$R = 40.6 K_{DP}^{0.866}$$ **Sachidananda and Zrnic (1987)**

Other advantages of the $R(K_{DP})$ estimator compared to R(Z) relations are:

- Independent of receiver and transmitter calibrations
- Much less affected by attenuation
- Less biased by the presence of hail
- Much less affected by beam blockage

4. Conclusion

It is shown that Serbian data were successfully transformed into the netCDF and ingested into the LAPS analysis system . The next step will be catching up with the products of dual-polarization radars to make an improvement in quantitative precipitation estimation, discrimination hail from rain with possible determination of size and identification precipitation in winter storms.

5. References

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- Giangrande, S. E., and A.V. Ryzhkov (2008); Estimation of rainfall based on the results of polarimetric echo classification. J. Appl. Meteor. Climatol., 47, 2445-2462
- Sachidananda , M., and D.S. Zrnic (1987): Differential propagation phase shift and rainfall rate estimation. Radio Sci., 21, 235-247